revisely

Thermal energy transfer

Internal energy

- **Internal energy** is that of an object's molecules due to their individual movements and positions.

- It is increased through:
  - energy transfer by heating
  - work done on the object (e.g. by electricity)

- If the internal energy is constant:
  - there is no energy transfer by heating and no work is done
  - or energy transfer by heating and work done balance each other out

- The first law of thermodynamics:in general, when work is done on or by an object and/or energy is transferred by heating:
  - the change of internal energy of the object = the total energy transfer due to work done and heating
  - the directions of the energy transfers are important in determining whether there will be a decrease or increase in internal energy

- The internal energy of the object is the sum of the random distribution of the kinetic and potential energies of its molecules.

- Celcius:
  - 0 °C - ice point, temperature of pure melting ice
  - 100 °C - steam point, temperature of steam at standard pressure (100 kPa)

- Absolute scale:
  - 0 K - absolute zero (-273 °C)
  - 273 K - triple point of water, where ice, water and water vapour coexist in thermodynamic equilibrium (i.e. objects at same temperature so no energy transfer by heating)

- Absolute zero is the minimum temperature any object could have - an object at 0 K has minimum internal energy regardless of its composition.

- A graph of gas pressure against temperature will always pass through the x-axis at absolute zero.

Specific heat capacity

Specific heat capacity, c, is the energy needed to raise the temperature of a unit mass of a specific substance by 1 K without a change of state. c has the unit J kg^{-1} K^{-1}.

$$\text{energy, } Q = mc\Delta T$$

For continuous flow heating, one must consider the energy supplied per second.

Change of state

A solid becomes a liquid thanks to energy being supplied at its melting point, where its atoms vibrate so much they break free from each other. The energy needed to melt a solid already at melting point is the **latent heat of fusion**.

Latent heat is released when a liquid solidifies because the liquid's molecules slow down as it cools until the temperature reaches the melting point. At this point the molecules move slowly enough for them to lock together - some of the latent heat released keeps the temperature at the melting point until all the liquid has solidified.

When a liquid becomes a gas the molecules gain enough energy to overcome the bonds holding them close together. The energy needed to vaporise a liquid is the **latent heat of vaporisation**. Latent heat is then released when a vapour condenses as its molecules slow down.

Some solids vaporise directly when heated: **sublimation**.

In general much more energy is needed to vaporise a substance than to melt it.

$$Q = ml, \text{ where } l \text{ is the specific latent heat and is measured in J kg}^{-1}$$

During a change of state the potential energies of the particle ensemble are changing but not the kinetic energies.